THE HISTORY OF THE FILARIA SANGUINIS HOMINIS, ITS DISCOVERY IN THE UNITED STATES, AND ESPECIALLY THE RELATIONSHIP OF THE PARASITE TO CHYLOCELE OF THE TUNICA VAGINALIS TESTIS.[1]

By WILLIAM M. MASTIN, M.D.,

OF MOBILE, ALABAMA.

FELLOW OF THE AMERICAN SURGICAL ASSOCIATION, AND MEMBER OF THE AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS.

IN this epoch of parasitical medicine, when the microscope stands as the arbiter of all disease, and the simplest pathological changes are ascribed, ofttimes upon the slenderest hypothesis, to the presence of some specific germ of either zoöid or phytoid life, it is of refreshing interest to turn to a form of parasite of which we possess a degree of exact knowledge, and that has been demonstrated to hold an intimate association in the relation of cause and effect to a diversity of morbid conditions. Furthermore, it now becomes a subject of increasing importance, since the boundary of its geographical existence[2] has been widened by its recent discovery in the United States—a territory until then regarded as not furnishing the surroundings essential to its indigenous life.

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[1] Read at the meeting of the American Association of Genito-Urinary Surgeons, Congress of American Physicians and Surgeons, Washington, D.C., September, 18th, 19th, and 20th, 1888.

[2] The positive dependence of one form of chyluria upon the presence of the filaria sanguinis hominis is so well established, that it may be said of the nematode as has been remarked of that disease, it is found usually in persons who, at sometime have resided in countries situated between the degrees of about 30° N. and 30° S. latitude. The worm has been discovered in, and is believed to be native to, the following countries and localities: Brazil—Bahia; India—Calcutta and Madras; Australia—Brisbane, Queensland; Egypt—Cairo; East Coast of Africa—Natal, also South Coast of Africa; China—city and district of Amoy, Foochow, and other portions; West Indies—Cuba and Guadaloupe; and since 1886, in the southern portion of the United States—Charleston, South Carolina, and Mobile, Alabama.

Dr. Myers, of Formosa, thinks from his researches that the surroundings of this island are not favorable to the reproduction of the filaria. This, however, is very questionable, since his data are too meagre to admit of a definite conclusion. (Vide Bibliography).

The conjecture, or rather belief, that the blood of man does occasionally become infested with animal organisms, particularly in the form of minute worms, is by no means a new or modern idea. On the contrary, this opinion, in addition to being deeply rooted .in the popular mind, has received the recognition of medical writers for centuries; but the examples brought forward from time to time in support of the theory have failed to supply the convincing testimony that the blood was their natural habitat. These instances, as far as ascertained, have belonged principally to the class of Distoma, especially the distomum hæmatobium (Bilharzia), which have been found occupying the vena portæ and other large vessels in direct or near proximity to the intestinal tract.

Again, other varieties of entozoa have been discovered in the vascular system, among which were probably young specimens of echinococci.[1] All of these, however, besides having been detected in several tissues of the body, possess a dimension beyond the capacity of the smaller blood-vessel ramifications; and, consequently, thus confined to vessels of comparatively large calibre, they could not gain access to the general circulation, and, therefore, can scarcely be viewed in the light of pure blood parasites.

Such was the existing status of our knowledge when, in 1872, the positive demonstration of a true hæmatozoon[2] fell to the fortune of Dr. Timothy Richards Lewis, of Calcutta, who discovered in a drop of blood, from the finger of a native youth, an embryo nematode to which he applied the descrip-

[1] Klencke, in 1843, discovered entozoa in the blood of an individual suffering from vertigo, but his description is too vague to admit of a positive assertion as to their exact character, although it is believed that they were most probably young specimens of echinococci.

[2] The designation of this nematode as a *true hæmatozoon* might be objected to very properly on the ground of Manson's recent discoveries; especially, that a lymphatic duct is the habitat of the adult worm (Filaria Bancrofti); that the embryos are often present in the lymph and lymphous discharge when absent from the blood; and that disorders of the lymphatic system are most frequently associated with the presence of the parasite.

tive title of *filaria sanguinis hominis*, and by which it is now most commonly known.

Renewed impetus was thus given to hæmic research—the vital fluid of man and animal alike was subjected to the scrutinizing vision of the microscope,—and, as in all brilliant and important discoveries, controverting theories and claims of priority were not tardy in arising and receiving vigorous support. These, together with the additional developments which rapidly followed, have thrown around the subject quite a confusing uncertainty; and hence there is found pervading its literature not only the contending claims of different observers, and statements misleading as to its identity with filarial discoveries in other localities and regions, but also the confounding of the embryonal with the mature form of the helminth.

It will scarcely be amiss, therefore, to review briefly the general history of the subject, and this will be facilitated by examining that of the embryo and parental worm separately, and arranging each important event in the chronological order of occurrence.

It is generally conceded, I believe, that to Dr. Otto Wucherer[1], of Bahia, Brazil, belongs the honor of being the first to discover the embryo-filaria. This occurred August 4, 1866[2], at which date, whilst searching for the *Bilharzia hæmatobia*, he found in the chylous urine of a female patient in the Misericordia Hospital, at Bahia, several of these, then unknown, living embryos in active motion; and again, he detected them a second time in the like fluid of another female suffering from hæmaturia, on October 9, of the same year. These specimens were sent to Leuckhart for identification, who suggested that they were the embryos of some round worm, belonging, most probably, to the Strongylidæ. Wucherer modestly declined, however, to assign to them an etiological significance, or even to offer a conjecture as to their coexistence with hæmato-chyluria, declaring that he preferred to wait until further investigation could be made, or, at least, the necropsic examination of a hæmaturic was possible.

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[1] Gazeta Medica da Bahia, Dec., 1868, p. 99.

[2] T. R.Lewis gives this date of discovery as 1868,(Quain's Dictionary of Medicine, Art. Chyluria, p. 250). Sir Joseph Fayrer speaks of it in one place as occurring in 1866, and on another page mentions the date as "1866 or 1868". (On the relation of Filaria Sanguinis Hominis to the Endemic Diseases of India. Read at the Epidemiological Society, Feb. 5, 1879, London Lancet, vol. 1, Feb. 8, 1879, p. 188 *et seq.*) I have placed it with Cobbold (Parasites: A treatise on the Entozoa of Man and Animals, including some account of Ectozoa, London, 1879, p. 181) in the year 1866, as recorded in the text, and which is the correct date, as shown by Wucherer' original publication referred to above.

Very naturally the parasite is sometimes spoken of as Wucherer's Filaria.[1]

Dr. J. H. Salisbury, in the United States, reported,[2] in the year 1868, the finding of a minute entozoon in the human bladder, which he described as a new species of nematode; and, although unacquainted with the mature form of the worm, classed it in the genus Trichina,—designating it *Trichina Cystica*.

He stated that he had met with it in the urine in three instances. In two of these its presence was not constant, being found only occasionally, whereas in the third case it occurred in great numbers,—not infrequently a single drop of urine containing no less than from ten to fifteen ova. This last case was a female, sixty-five years of age, with partial paralysis, who had been insane for several years, and was then suffering from "cystenic rheumatism" or "cystinemia," and voiding a milky urine, dense and scanty, filled with granular cystine, but without blood admixture. The history of this case is extremely meagre, and, furthermore, no reference whatever is made to the physical condition of the other two patients, which greatly lessens the value of the discovery.

In a report published in 1870 by the British Government,[3]

[1] Also termed Wucherer's Embryonic Filaria.

[2] Art. VI. On the Parasitic Forms Developed in Parent Epithelial Cells of the Urinary and Genital Organs, and in their Secretions. (With thirty-four illustrations.) Amer. Jour. Med. Sci., No. cx., April, 1868, pp. 376-77

Dr. Salisbury's paper contains two wood-cuts of the ova (Figs. 29 and 30), and one of the escaped embryos (Fig, 31), all of which are fair illustrations of the parasite as we now know it.

[3] British Medical Journal, Nov. 19, 1870 (abstract.) Also: On a Hæmatozoon Inhabiting Human Blood: Its Relations to Chyluria and other Diseases, by T. R. Lewis, Eighth Ann. Rep't. Sanitary Comm. with Govm't of India, 1871, Appendix E. Calcutta, 1872. Also: Quain's Dic. Med., Art., Chyluria, p. 250. Also: A Prac. Treatise on Urinary and Renal Diseases, etc., by William Roberts, M.D. London, 1876, p. 597.

Dr. T. R. Lewis, being then ignorant of previous observations of a similar character, stated that in March, 1870,[1] he had found in milky urine, voided by a man under the professional care of Dr. R. T. Lyons in Calcutta, numerous living microscopic nematoid worms. Specimens of these, forwarded to Dr. Parkes, were seen and examined by Prof. Busk, who considered them as belonging to the Filaridæ.

This was the earliest discovery in India, and was verified in the course of the next few months (end of 1870 or beginning of 1871) by Dr. W. J. Palmer and Dr. Charles,—these observers detecting the same entozoa in chylous urine of other patients in Calcutta.

On, and shortly prior to, July 25th, 1870, T. Spencer Cobbold,[2] of London, observed the larvæ of a minute nematode in the urinary deposit of a case of "Bilharzia," from Natal. These were obtained on several occasions, were well-developed, in a state of activity, and in goodly numbers, as many as fifty being counted at one examination. He regarded them as identical with the embryos described by Salisbury; but realizing that these organisms represented parasites in their primary embryo stages, and appreciating how frequently errors of interpretation had already gained access to helminthological literature, he was particularly cautious in giving expression to any direct or positive views in relation to them. Consequently, he avoided the adoption of a special name, and, indeed, refused to speculate either as to their origin or pathological importance.

Almost coincident with this date, July 27th, 1870, Dr. Jules Crévaux,[3] a French Naval Surgeon, supplied additional confirmation of these observations by finding like entozoa in the

[1] Sir Joseph Fayrer (On the Relation of Filaria Sanguinis Hominis to the Endemic Diseases of India, loc. cit.;) erroneously gives this date as 1869.

[2] Appendix to a paper on "Bilharzia," communicated to the Metropolitan Counties Branch of the British Medical Association, May 17, 1872. (vide Cobbold's work on Parasites: A treatise on the Entozoa of Man and Animals, etc., London, 1879, pp. 182-3.

[3] De l'hematurie Chyleuse, etc., 1872. Also: L'Union Medicale, 1872. Also: Jour. de l'Anat. et de la Physiol. T. xi. 1875. Also: Quain's Dict. Med. Art. Chyluria, p. 250. Also: Cobbold, Op. Cit. p. 184. Also: Leuckhart's "Parasiten," bd. 11, p. 628, *et seq.*

urine of a young creole affected with "hematurie chyleuse," at Gaudaloupe. He searched the blood[1] of the same patient for parasites on several occasions, but with negative results. These examinations were made in conjunction with Dr. A. Corre,[2] who also published a careful description of the worms.

Undoubtedly the most important event among the various historic and scientific developments associated with the filaria was the discovery of its presence in human blood, in July, 1872.[3] As already mentioned, this was made by Dr. T. R. Lewis whilst examining the blood from the finger of a Hindoo patient, suffering from diarrhœa, in the Calcutta Medical College Hospital, when he found nine of these nematoid entozoa in a single slide. Later he detected them again in the blood of a chyluric; and since the original discovery he has traced them directly to the blood of about fifteen individuals, and to the several tissues and secretions of thirty-five others,[4]—all of whom, except the first, were, or had been, the subject of chyluria, or some morbid condition bearing thereto intimate pathological relations.

From Egypt comes the next advance in the measured march of discovery. This step was independently taken by Dr. Prospero Sonsino, of Cairo, in his "find" on February 1, 1874, and which he made known a few months later in a communication[5] addressed to the Neapolitan Royal Academy. In this memoir he remarks that the host was an Egyptian Jew boy, residing in Cairo, fifteen years of age, the subject of hæmaturia. A drop of blood from this lad's finger placed under the microscope disclosed to his astonished vision "a living organism of the form of a nematode, resembling *Anguillula*, in the midst of the hæmatic corpuscles."[1] The nematode was found also in the urine,[2] which, in addition, contained distoma.

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[1] It should be mentioned in this connection that Dr. J. da Silva Lima, of Brazil, made blood examinations for hæmatozoa, but these also were in vain (vide Cobbold, Op. Cit. p. 184.)

[2] Note Sur l'helminthe rencontre dans les urines hémato-chyleuses, Rev. des Sci. Nat. 1872. Also: Cobbold, Op. Cit., p. 184.

[3] T. R. Lewis, On a Hæmatozoon in Human Blood: Its connection with Chyluria and other Diseases. Eighth Ann. Rep't. of the Sanitary Comm., with the Govm't of India, Calcutta, 1872. Also: Quain's Dic of Med, 1883, Art. Chyluria, p. 250. Also: On the the Pathological Significance of Nematode Hæmatozoa. Tenth Rep. of Sanitary Comm. with the Govm't of India, 1874. Also: Sir Joseph Fayrer, On the Relation of Filaria Sanguinis Hominis to the Endemic Diseases of India, London Lancet, Vol. I., Feby. 8, 1879, p. 188. Also: Cobbold, Parasites: A Treatise on the Entozoa of Man and Animals, etc., 1879, p. 184.

[4] These statistics were given by Lewis in 1882. (vide Quain's Dic. Med. loc. cit.)

[5] Richerche intorno alla Bilharzia hæmatobia in relazione colla Ematuria Endemica del'Egitto e nota intorno un nematoideo trovato nel sangue umano. Estr. dal Rend. del R. Accad; April 20, 1874. Also: Cobbold, op. cit. p. 185. Also: Sir Joseph Fayrer, On Filaria Sanguinis Hominis Ægyptiaca, London Lancet, vol. 1, Aug. 26, 1876.

Not finding in these specimens the delicate enveloping sac or chorional tunic, which Lewis described as characteristic of the embryo, he believed that he had been made acquainted with a form of filaria differing from the Indian variety, and, therefore, suggested as an addition to its original name the distinguishing suffix of *Ægyptiaca*, thus entitling the hæmatozoon, *filaria sanguinis hominis Ægyptiaca.*

Ascertaining at a later period, however, that the external envelope was not constant, but, on the contrary, only the embryo skin separating by ecdysis—a desquamation or moulting, as it were, of the embryo—and which further personal observations enabled him to verify, he declared[3] that then the reason no longer existed for looking upon the Egyptian worm as belonging to a different species from the one discovered in India by Dr. Lewis, and consequently discarded the supplemental term.

The geographical distribution of the hæmatozoon was still further enlarged by O'Neill[4] in 1875, on the south coast of Africa, who found embryo-nematodes in the exudate from the skin in a disease known to the negroes as *craw-craw*; and by Silva Araujo,[5] at Bahia, who also saw them in the cutaneous exudate from a negro, the victim of the same affection (craw-craw), and which he called *filaria dermethemica.*

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[1] Op. cit. pp. 11 and 12.

[2] He found it again shortly afterwards in the urine of another hæmaturic.

[3] Filaria Sanguinis Hominis, Lymphocele, Lymphuria, and Other Associated Morbid Disorders; With a hint of Other Worm Diseases in Egypt. Med. Times and Gazette, March 13, 1882.

[4] On Craw-Craw. Lancet, London, Feb'y, 1875. Also: Sir Joseph Fayrer, On the Relation of Filaria Sanguinis Hominis to the Endemic Diseases of India. London Lancet, Feb'y 8, 1879.

[5] A. J. P. da Silva Araujo, Memoria sobre a filariose, ou a molestia produsida por uma nova especie de parasita cutaneo. Bahia, 1875. Also: Archiv. Med. Nav. 1875 and 1878. Also: Sir Joseph Fayrer, on the Relation of Filaria Sanguinis Hominis to the Endemic Diseases of India. Loc. cit.

Again, the filaria was detected, in 1876,[1] by Dr. J. Bancroft,[2] of Brisbane, Queensland, Australia, in the blood of a little girl, ten years old, the subject of chyluria. Blood from this patient was sent to Dr. William Roberts, of Manchester, who, together with Dr. Cobbold, examined it, and were thus able to verify the presence of the filaria embryos.

These were accompanied or soon followed by the observations of Patrick Manson,[3] in China, Silva Lima and Dos Santos, in Brazil, Finlay[4] in Cuba, and numerous other workers in tropical and sub-tropical countries.

Among the embryos in the filariated blood sent to England from Australia by Dr. Bancroft (*vide supra*) was found a solitary and empty egg-shell. This fact was almost direct proof of the belief already entertained that the filaria was the larval stage of some larger nematoid worm, and, therefore, Dr. Cobbold hastened to inform Bancroft of its presence, thereby inducing the latter observer to persevere in his researches in this department of helminthology.

These investigations, although attended by much laborious work, were so successfully conducted that, in a letter to Dr. Cobbold, dated April 20, 1877, he conveyed the intelligence of the discovery of the parent parasite, which was a dead female[5] obtained, on Dec. 21, 1876,[6] from a lymphatic abscess of the arm. Again, on another occasion shortly thereafter, he procured four additional specimens, all females and alive, from a

[1] Chyluria is common in Brisbane, and this case of Bancroft's was not the only one in which he had already discovered filariæ in the blood; and hence it is very evident that his original discovery was prior to 1876—probably the previous year, although I do not know the date.

[2] Cobbold, op. cit., p. 186.

[3] Cobbold, op. cit.

[4] Charles Finlay, Consideraciones a cerca de algunos casos de filariosis observados en la Habana. An. re Acad. de Cien. Méd. de la Habana, 1882-3, xix, 40-51.

[5] The mature female is a long, thread-like worm, from 3½ to 4 inches in length, and 1-90 inch in breadth. The male is more plump and somewhat smaller.

[6] Cobbold, op. cit. p. 187. Also: Sir Joseph Fayrer, on the Relation of Filaria Sanguinis Hominis to the Endemic Diseases of India. Lond. Lancet, vol. 1, Feb'y 8, 1879, 188. Also: Quain's Dic. Med. Art. Filaria Sanguinis Hominis, p. 512-13.

hydrocele of the spermatic cord, having caught them, entwined together, in the eye of a "peculiar trocar" used by him for tapping; and a few months later he forwarded all five[1] of these to Dr. Cobbold for examination.

In the following July Dr. Cobbold announced[2] this discovery of Bancroft's, giving to the mature worm the binomial term of *filaria Bancrofti*; and, in October of the same year, after an attentive examination and study of the specimens sent from Brisbane, he published[3] a second account of the discovery with a minute and carefully prepared description of the adult form.

In the same year, 1876, and possibly antedating the discovery by Bancroft, the parent filaria was found by Carter in India, in "a lymphatic abscess and hydrocele of the spermatic cord."[4]

Two living specimens of the mature helminth, male and female, were found by Dr. Lewis on August 7, 1877.[5] These were harbored by a young Bengalee lad suffering from well-marked nævoid elephantiasis of the scrotum,[6] associated with embryo-filariæ in the blood, and were found coiled together in a blood clot contained in the removed scrotal tissue, the operation being performed by Dr. Edward Gayer, of Calcutta. Unfortunately, during the "teasing" of the clot, these specimens were badly injured, resulting in the destruction of the terminal extremities of the male and the caudal end of the

[1] The individuals from whom these specimens were taken were not known to harbor embryo-nematodes in their blood (vide Quain's Dic. Med. Art. Filaria Sanguinis Hominis, p. 513).

[2] London Lancet, July, 1877.

[3] London Lancet, October 6, 1877.

[4] Vide Sir Joseph Fayrer, On the Relation of Filaria Sanguinis Hominis to the Endemic Diseases of India. Loc. cit. p. 188.

[5] Indian Medical Gazette, Sept. 1, 1877. Also: Lancet, London, Sept. 29. 1877. Also: Centralblatt für d. Medicinische Wissenschaften, No, 43, 1877. Also: Quain's Dic. Med. Art. Filaria Sanguinis Hominis, 512-13. Also: Sir Joseph Fayrer, On the Relation of Filaria Sanguinis Hominis to the Endemic Diseases of India, Lond. Lancet, vol. 1, Feb'y 8, 1879, p. 188. Also: Cobbold, Parasites, etc. p. 187.

[6] The term nævoid elephantiasis is synonymous with varix lymphaticus, lymph scrotum, etc.

female. Hence the male[1] specimen was too much mutilated to admit of an accurate description of its specific characters.

In the paper[2] describing this discovery Lewis objected to the nomenclature employed by Dr. Cobbold, declaring that the appellation of *filaria sanguinis hominis* originally given by him to the embryonal entozoon should be retained for the adult nematode. While it must be conceded that there are valid reasons in favor of Dr. Lewis' proposition, and not the least, the avoidance of much confusion by including both the mature and immature filaria under one and the same designation, still there are also certain well-founded objections to be urged against it; and especially, as suggested by Cobbold, because the name of filaria Bancrofti serves to fix the date and source of the discovery, giving to Dr. Bancroft the credit to which he is justly entitled.

The discovery received additional verification at the hands of Araujo,[3] of Brazil, who found the parent worm October 16, 1877; by Dos Santos,[4] in conjunction with J. de Moura, also of Brazil, in a case of lymphatic abscess of the arm, on November 12, 1877; and by the "find" of Dr. Manson,[5] of Amoy,

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[1] This void in our knowledge of the characters of the male filaria was more recently supplied by Prof. A. G. Bourne, of Madras, who secured a perfect male specimen from a case of lymphoid scrotum (vide British Medical Journal, abstract in the Amer. Practitioner and News, No. 65, June 23, 1888, p. 406.)

[2] London Lancet, Sept. 29, 1877.

[3] Caso de Chyluria, Elephancia do Escrôto, Escrôto lymphatico, Craw-Craw, e erysipela em um Mesmo individuo; descobrimento da Wuchereria filaria na lympha do escroto. Tratamento pela Electricidade Com Excellentes resultados. Gaz. Med. da Bahia, 2 a Serie, vol, 20, No. 11, Nov. de 1876. Also: Cobbold, Op. Cit. 193-4. Also: Fayrer, On the relation of the Filaria Sanguinis Hominis, etc. London Lancet, vol. 1, Feb. 8, 1879.

[4] Filaria Pancroft: Verificação no Brazil da descoberta de Brancroft, na Australia, Progresso Med., Rio de Jan., 1877-8, 11, 95 100, Also: Gaz. Med. da Bahia, March, 1887. Also: Cobbold, Op. Cit. Also: Fayrer, loc. cit.

[5] Additional Notes on Filaria Sanguinis Hominis and Filaria Disease. China Imperial Maritime Customs. Med. Reports for the half year ended Sept. 30, 1880. Also: The Filaria Sanguinis Hominis and Certain New Forms of Parasitic Diseases, etc. London, 1883, p 123-7.

Manson also found fragments of the mature female worm in a case of thigh-abscess, Jan. 10, 1881.

China, October 15, 1880, in the diseased tissues of lymph-scrotum.

The cases of Araujo and Manson deserve more than passing mention: Araujo's case was unique and of the greatest clinical and pathological importance, since he harbored not only the mature and embryonic nematodes, but, at the same time, he presented in his own person several of the disorders attributed to the presence of embryo-filariæ, and previously found separately. At first he suffered from chyluria; two years thereafter he experienced several attacks of craw-craw; then a second out-break of chyluria appeared, during which attack lymph-scrotum associated with elephantiasis scroti became manifest.

The patient of Manson was of both practical and scientific interest. He was a native Chinaman; male; 46 years old; afflicted with lymph-scrotum. No embryo-entozoa were discoverable in the blood, but were abundant in the lymph discharge; and a live, active, mature female was found occupying a dilated lymphatic vessel on the cut surface of the abscised scrotum. This is the first instance where the true home of the parent conld be precisely stated from direct observation, and which, together with the number of recorded[1] cases wherein the immature parasite was absent from the blood, but its presence amply demonstrated in the gland-lymph or lymphous discharges,seems to threaten a revolution, or, at least, a material change in the views at present entertained concerning the hæmatic relations of the embryo-filaria.

Upon these facts Manson bases the theory, and which he considers proven[2], that the lymphatics—and more frequently the distal vessels—are the chosen and natural habitat of the adult nematode. He argues that the female lying in a lymphatic duct emits her young which are carried by the lymph-current to the lymphatic glands, and having a diameter about equal to the lymph-corpuscles, plus the aid afforded by their own vigorous movements, they readily enter and traverse the gland-tissue. Thus they pass gland after gland, and emerging

[1] Observed especially by Manson.

[2] The Filaria Sanguinis Hominis, etc. London, 1883, p. 6.

into the efferent vessels are borne along the stream until the thoracic duct is reached, and finally enter the blood itself.

The next link in the complicated chain constituting the life history of the parasite—a problem worked out by pure inductive reasoning,—was the tracing of the embryo-filaria to the body of the *culex mosquito.*

That the mosquito might be the intermediary host was first suggested by Bancroft, who informed[1] Dr. Cobbold, in April 1877, that he suspected the larvæ were imbibed by mosquitoes and other suctorial insects whilst engaged in their predatory attacks upon man.

Again, in the summer of the same year, Dr. Manson[2] reasoning independently by a similar method, that, as the filarial embryo resides and circulates in the blood, the primary step in its development must be its freedom by some agent which abstracts the blood, and hence concluded that the mosquito or sand fly was the medium through which liberation was effected. With a zeal and thoroughness characteristic of this acute and able observer, he lost no time in subjecting this opinion to experimental test, and in quite a short period his efforts were crowned by the actual observation of this human embryo-hæmatozoon in the stomach of the culex mosquito.

He first communicated this discovery on January 4, 1878, in a manuscript to Cobbold, who hastened to give publicity through the columns of the *London Lancet*[3] to the main facts connected therewith.

Additional examination convinced Dr. Manson that every variety of this culex did not possess the requisite qualifications to serve as the intermediate host, but that such was limited to the female of a particular species of mosquito, and which he describes.

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[1] Letter to Cobbold (Vide Cobbold, Op. Cit. p. 192).

[2] China Imper. Customs, Medical Reports No. xiv, 1878. Also. Linnæan Soc. Jour. of Zöology, vol. xiv. p. 304. Also: Filaria Sanguinis Hominis and Certain New Forms of Parasitic Disease, etc. London, 1883, p 10.

[3] London Lancet, January 12, 1878, vide also: Manson On Filaria Sanguinis Hominis, and on the Mosquito Considered as a Nurse. Proc. Linn. Soc. March 7, 1878. Also: "Nature," March 28, 1878, p. 439.

He then demonstrated that the female of this special variety penetrating the skin of a victimized subject, deeply buries her proboscis in the blood-current, and to which the circulating embryos quickly adhere, becoming attached or entangled by means of their lashes[1] or loose chorional envelopes. Being securely held in this manner they are the more readily conveyed in large numbers along with the blood to the stomach of the mosquito; and after thus gorging herself she repairs to water to fulfil the chief aim of life—the deposit of her ova.

Many of the embryo-nematodes are digested or expelled in the excreta, but a few, obedient to the decree of the survival of the fittest, remain to undergo interesting developmental changes. These changes require from four to six days for completion, and at the expiration of this period the metamorphosed filariæ are then discharged either with the larvæ, or gain their liberty by boring through the body of the insect after dissolution, and thus probably escape into the water in the state of free nematodes.[2] Through this medium infection undoubtedly occurs either by the avenue of the mouth—being swallowed in potable water, or by penetrating the skin of bathers; but this is simply conjectural, and hence a broad hiatus exists here in our knowledge of the wonderful life-cycle of the animal, which will require both time and a peculiar association of propitious circumstances to bridge-over.

On re-entering the human body, whether directly or possibly through the agency of another bearer, it soon reaches sexual maturity and seeks its destination in the lymphatic system—probably a distal branch,—where it is accompanied or followed by the male, and conjunction of the sexes takes place.

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[1] Dr. Manson believes that the lash is a special provision to thus aid in accomplishing the passage of the filaria sanguinis hominis to the intestinal tract of the mosquito.

[2] Dr. Pedro S. de Magalhães, of Rio de Janeiro, found microscopic nematodes in the drinking waters of Rio(Aqua da Carioca), which he thinks may be genetically related to Filaria Bancrofti. This relation, however, Dr. Cobbold rejects (Vide Filarias em estado Embryonario; encontrados Niagua tida Como potaval (agua da Carioca). Progresso Med Rio de Jan. 1877, 57-62. Also: Gaz. Med. da Bahia, 1878, 2. s., III, 14-19, Dezembro. Also: Nota Sobre os nematodes encontrados no Sedimento deposito pela agua (potavel) da Carioca. O Progresso Med. 1 de Setemb. 1878, p. 577. Also: Cobbold, Op. cit. p. 194.

Speaking of this important rôle of the mosquito in an article[1] published in 1878, Dr. Lewis, of Calcutta, stated that he had made frequent examinations, but in a cursory manner, of both this and other suctorial insects, in quest of these filarial guests, and always negatively; when, a few months prior to that writing, he received a communication from Dr. Manson which directed his attention anew to the subject. Great then was his surprise to find that four out of eight mosquitoes, captured at random in one of the servant's houses, harbored specimens of hæmatozoal embryos identical, apparently, with those he had previously seen in man.

These researches were conducted with considerable caution; and from these later inquiries he was convinced that although a great number of the ingested hæmatozoa are digested, "nevertheless others actually perforate the walls of the insect's stomach, pass out, and then undergo developmental stages in its thoracic and abdominal tissues." Therefore he was able from personal knowledge to add a positive voice in substantiation of Manson's discovery.

Dr. da Silva Lima, of Brazil, wrote[2] to Dr. Cobbold, in the month of September, 1878, announcing the fact that Dr. Araujo had verified the presence of the embryos of *Filaria Bancrofti* in mosquitoes, at Bahia. These mosquitoes had fed upon the blood of a French priest, in whom embryo-filariæ were known to exist.

This was speedily followed by a similar announcement from Bancroft,[3] who sent, from Brisbane, some filariated mosquitoes[4] to Dr. Cobbold, on April 15, 1879, which had feasted upon the blood of a filaria-infested patient.

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[1] T. R. Lewis: Remarks Regarding the Hæmatozoa Found in the Stomach of the Culex Mosquito. Proc. Asiatic Soc.-Bengal, March. 1878, p. 89. Also. Cobbold, Op. Cit. p. 196-7.

[2] Cobbold, Op. Cit. p. 198.

[3] Cobbold, Op. Cit. Appendix, p. 487.

[4] Bancroft detected forty five filariæ in the body of a single mosquito obtained from this source.

Again, Dr. Prospero Sonsino, of Cairo, soon reported[1] that he too had recently witnessed the metamorphosis of the filaria in the body of the mosquito, having encountered the embryos and watched the process of development in nine out of thirty-six mosquitos examined.

These were the mosquitoes ordinarily found about Cairo.

Thus the mosquito as the true secondary or intermediary bearer of the filaria sanguinis hominis became an established fact,—founded upon the firm basis of direct and repeated observation.

Viewed from a physiological stand-point, perhaps the most curious and remarkable feature connected with the entire subject of the filaria sanguinis hominis, and with which the name of Manson is also intimately and inseparably associated, is the singular phenomenon not inaptly designated by Cobbold as *filarial periodicity*.[2]

In examining the blood of filaria-bearing persons, Dr. Manson noted the fact that the embryos were sometimes markedly diminished in, and frequently temporarily absent from, the general circulation,—particularly during the diurnal hours. Appreciating that he had recognized a condition of unusual import, but realizing the numerous difficulties which beset the path to an explanation, he determined to attempt an investigation of the rationale of these disappearances. Consequently, he instituted a series of systematic observations in a number of patients, with the result of learning that, "unless there is some disturbance, as fever, interfering with the regular physiological rhythm of the body, filaria embryos invariably begin to appear in the circulation at sun set; their numbers gradually increase till about midnight; during the early morning their numbers become fewer by degrees, and by nine or ten o'clock in the forenoon it is a very rare thing to find one in the blood.[3]" Hence it became obvious that what at first appeared to be only irregular happenings, were in reality attended by the most precise and absolute regularity; in a word, that the embryos always desert the circulation during the day, and as surely and uniformly re-enter it on the going down of the sun, and increase in numbers with the approaching hours of night.[1] Dr. Manson did not have to seek long for the interpretation of this peculiar periodicity. His discerning mind at once saw in it a beautiful example of the operation of a grand natural law, namely, the adaptation of the habits of the filaria to the nocturnal wanderings of its indispensable liberator and secondary host,—the mosquito.

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[1] Filaria Sanguinis Hominis, Lymphocele, Lymphuria, and other Associated Morbid Disorders; with a Hint of other Worm Diseases in Egypt. Med. Times and Gazette, May 27, 1882, p. 554. Also: Manson, Op. Cit. p. 11, note. Also Cobbold, Op. Cit. p. 192.

[2] Manson, in China Imper Customs Med. Reports, xxiii, p. 36. Also: The Filaria Sanguinis Hominis, etc., London, 1883, p. 32, *et seq.*

[3] Manson, Op. Cit., p. 34.

But whilst the object of this periodicity was apparent, the cause, agency or producing force was shrouded in obscurity, and, indeed, remains unelucidated.

Just here the queries naturally arose: Whether the periodic absence of the filarial embryos was caused by their death, and the appearance of a new brood every twenty-four hours ; and, If not occasioned by dissolution, then what and where was the chosen place of their concealment during the hours of retirement? In order to determine these pertinent questions Dr. Manson resorted to experiments upon, and post mortem examinations of, dogs infested with the *filaria immitis*,—a hæmatozoon very analogous to filaria sanguinis hominis. These investigations disclosed the fact that there is a certain imperfect periodicity, or, in other words, a periodic remission in numbers in the canine hæmatozoal embryos ; and, again, that instead of dying and disintegrating during these remissions they are to be found resting in the minutest ramifications of the pulmonary artery. Therefore, he very reasonably concludes that something similar takes place with the human parasite, and that they do not die, but lie resting and waiting for the evening hours in some of the thoracic or abdominal organs.[2]

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[1] Manson's recognition of filarial periodicity was confirmed by Dr. Myers, of Formosa, Dr. Stephen Mackenzie, of London, Dr. Rennie and Dr. Adams, of Foochow, and others.

[2] Dr. W. Wykeham Myers thinks that filarial periodicity is due to the embryos

On account of the periodicity being one of every twenty-four hours, Manson suggested the proposition that it might be influenced possibly by the regular diurnal revolution of the earth,[1] operating either directly upon the parasite in the human blood by means of some of the regular quotidian and rhythmic fluctuations in the meteorological conditions produced thereby,—as rise and fall of temperature, differences of atmospheric pressure, the waxing and waning of light, and variations in terrestrial magnetism; or, indirectly, by inducing in the human bearer certain daily and methodic habits upon which depend the actions of the nematoid embryos,—such as the periods of waking and sleeping, evening rise of body temperature, exercise, the time of taking food, and such like.

Subsequent systematic observations by himself, together with examinations by others, however, enabled him to eliminate the *direct* operation of these influences, and hence he now considers that "filarial periodicity is dependent, not on meteorological conditions resulting from the daily revolution of the earth, but on the *habits* this great fact impresses on the human body."[2]

As having a special bearing upon this opinion must be men-

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possibly dissolving away in the blood every twenty-four hours, rather than retreating to some organ, cavity or part of the blood-vessel system as believed by Manson. The languid condition of the embryos found in the morning is the basis of this belief, but the theory is very unstable because founded upon examinations in a single case (vide observations on Filaria Sanguinis Hominis in South Formosa. China Imper. Customs Med. Reports, 11 Special Series No. 2. Half year ended 31st March, 1881, 21st issue.) This theory was refuted by Manson (Op. Cit. p. 92, *et seq.*) but, it must be added that Dr. Prospero Sonsino agrees with Myers that the life of the embryo-filaria in the blood is short and ephemeral, although he was unable to substantiate the assertion that the filariæ in blood drawn at night are always more vigorous and active than those in blood taken in the diurnal hours. (Filaria Sanguinis Hominis, Lymphocele, Lymphuria, and other associated morbid disorders; with a Hint of Other Worm-Diseases in Egypt. Med. Times and Gaz. May 27, 1882, p. 554.)

[1] Manson, Op. Cit. Chap. 11, p. 32, *et seq.* Also: On the Periodicity of Filarial Migrations to and from the Circulation. China Imper. Customs. Med. Reports. Half year ended 30th Sept., 1881, 22nd issue.

[2] Manson, Op. Cit., p. 54.

tioned the theory of Dr. Mortimer Granville[1], who thus briefly formulates his ideas: "The modifications of blood-current and pressure, of the relative amounts of oxygen and carbonic acid received into or liberated from the blood, of the relative temperatures of the blood and the tissues, and the chyle current, which are concomitant or consecutive to the sleep-state, are, I believe, essential to the appearance of the filariæ in blood." Closely connected with, and the most decided step towards bringing about, these conclusions in regard to the phenomenon of filarial migration as they stand at present, and which, fortunately, has largely circumscribed the field of research, was Stephen Mackenzie's discovery of the *inversion of filarial periodicity*,[2] which was effected by simply changing the habits of sleeping and waking in a filariated patient.

Notwithstanding that filarial periodicity is still in the dark, and that much remains to be accomplished before its significance will be correctly understood and thoroughly appreciated, there are several points which may be fairly considered to be practically demonstrated, as follows: Filarial periodicity is unaffected by either continued watching, or change in the hours of eating; but it is possibly disturbed by prolonged sleep, and by increase in body-heat or the febrile state.[3]

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[1] "Filaria Sanguinis Hominis and Fever" (letter by J. Mortimer Granville, dated Feb'y 20th, 1882), London Lancet, Feb'y 25th, 1882, vol. i, p. 314.

[2] On October 18th, 1881, Dr. Stephen Mackenzie exhibited to the Pathological Society the subject of this experiment, who was a soldier having served in India, and then an inmate of the London Hospital.

Filarial inversion was confirmed by Manson, who verified and varied Mackenzie's experiments (On the Periodicity of Filarial Migrations to and from the Circulation, China Imp. Customs Med. Reports. Half year ended 31st March, 1882, 23rd issue, pp. 5 and 6. Also: The Filaria Sanguinis Hominis, etc., London, 1883, p. 54, *et seq.*)

[3] It should be mentioned that in two cases in which the influence of chloroform upon filarial periodicity was noted, in one no effect was observable, but in the other the administration of the anæsthetic seemed to cause the appearance of the embryos in the circulation at an hour when they are to be considered normally absent. (Manson, Op. Cit. pp. 94 and 105.)

In this connection an important abservation was made by Dr. DeSaussure, of Charleston, S. C., on a filariated negress under his professional charge, who was pregnant. The filariæ existed in the blood the night before labor, but immediately after labor they were absent. Subsequently, however, they again appeared in the blood. Blood from the cord did not contain the embryos (vide case 8, table of cases in this article).

We now come to the consideration of the finding of the filaria in the United States.

Had Dr. Salisbury been more specific in his description of the new species of nematode which he found in the human bladder in 1868 (*vide supra,*) and particularly had he furnished an accurate and detailed history of the patients from whom these minute organisms were obtained,—especially as to their nativity and the absence of residence in a tropical latitude, we might have been able to accord to him the honor of discovering the parasite on this Continent. But with the existing status of the subject, to Dr. John Guitéras, of the U. S. Marine Hospital Service, is due the full credit of being the first to demonstrate that the filaria sanguinis hominis is a native, or at least, a thriving colonist of the southern portion of the United States.[1]

In 1884, whilst stationed at Key West, Florida, Dr. Guitéras discovered the embryo-filaria in the blood of four persons, but all of these were from the Island of Cuba, and hence the cases were easily traceable to a non-American origin.[2] However, he recognized then that the local conditions and surroundings were favorable to the indigenous life of the worm.

On going to Charleston, in 1885, he found there a climate quite similar to that of South Florida; also that the city had been for years in constant commercial intercourse with the West Indies; that elephantiasis was not infrequently met with; that mosquitoes abounded; and that cistern water without filtration was in very general use for drinking purposes. These facts seemed to offer every requirement necessary for and conducive to the existence and developmental cycle of the filaria; and, therefore, he made known his belief to other practitioners of the town, and began himself a systematic look-out for the parasite.

[1] The Filaria Sanguinis hominis in the United States—Chyluria, by John Guitéras, M. D., Medical News, April 10, 1886, p. 399.

[2] The filaria has been found in the United States in a few other non-indigenous cases, among which may be mentioned the patient of Drs. Abbé (New York Medical Journal, Feby. 1880) and C. E. Hackley (Further Notes on a Case of Filaria Sanguinis Hominis, Archiv. Med., N. Y., 1882, viii, 142-148. Also: Reprint. Also: Filaria Sanguinis Hominis: Buck's Reference Hand Book of the Medical Sciences, pp. 156-57.)

His searches were unsuccessful until February 13th, 1886, when he examined with Dr. P. G. de Saussure, of that city, a case of chyluria from the clientelage of Dr. J. J. Edwards, by whom the existence of the parasite was suspected, and in whose blood filariæ were found in plentiful numbers. This patient was a mulattress, a Charlestonian by birth, and had never been out of the city except during a residence of five years in Augusta, Georgia. Her history rendered it impossible to say in which location she had acquired the malady, but Dr. Guitéras was inclined to regard Charleston as the most probable place of origin, especially on account of the source of the potable water supply.

The seed thus sown by Guitéras flourished and brought forth early fruit, for, within the same year, three additional cases were noted in rapid succession. The first[1] of these occurred also in the practice of Dr. Edwards, who recognized and referred it to Dr. Giutéras, on March 6. This was in the person of a negro man suffering from chylocele, associated with commencing elephantiasis scroti, and whose blood teemed with the hæmatozoal embryos. He had never been beyond the limits of the immediate vicinity of Charleston, and hence the place of infection did not admit of question. The other two cases[2] were under the professional charge of Dr. de Saussure. One was a negro man, born and reared in Charleston, the subject of chyluria, and presented the embryos in both the blood and urine; the other was a mulatto woman, at the advanced age of one hundred years, who was born in San Domingo, but had been a resident of Charleston since early life. She was insane, and had superficial abscesses. The filariæ were in the blood.

In 1887 six cases[3] were observed. Five of these occurred in Charleston, and among which were four chylurics, the patients of Dr. de Saussure, and one affected with lymph-scrotum, nnder the surgical care of Dr. R. A. Kinloch. The embryos were in the blood of all, besides being additionally in the urine of one. The only other noteworthy feature connected with them, was in one of the patients of Dr. de Saussure, a negress, æt. 32 years, laundress by occupation, and in the last month of pregnancy. The night preceding labor the filariæ were present in the blood in the usual numbers, but were absent immediately after accouchement, which took place at ten o'clock P. M. Subsequently, however, they reappeared in the circulation. Blood from the cord did not contain the nematodes. This is an important and valuable observation, and may serve to shed some light on the obscure but interesting subject of filarial periodicity.

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[1] Guitéras, loc. cit. note, p. 402.

[2] Guitéras in MS. to the writer.

[3] Ibid.

So far in 1888, three cases[1] have been met with. These were seen by Drs. John Guitéras, J. L. Dansen, Jr., and de Saussure, respectively. Chyluria was the pathological conditions present in each, and filariæ existed in the blood.

In order that the prominent and essentials points of these cases, including all the American cases, may be the more readily observed, I have arranged them in the subjoined tabular form. In this table cistern water is indicated as the principal source of the potable water in the Charleston cases; but in reference to this it is necessary to remark, that rain water was not exclusively drank by these individuals, since they all partook more or less frequently of the artesian water of the city water supply. "This water is exposed in a pond before going into the pipes, and may be infected with filarious mosquitoes." [2]

There now remains to be considered the case, belonging to the group of 1887, which came under my personal observation, and which forms the basis of this essay.

J. P. Mallon, a cabman by occupation, æt. 22 years, white, born in Mobile, of Irish parentage, brunette, of slender frame but moderately robust, consulted Dr. C. H. Mastin, (Senior), on September 27, 1887, in relation to an enlargement of the left testis. Inquiry elicited these points in his history: There is no history of either hereditary or acquired disease. His father died of acute cerebral congestion at the age of 53; but his mother is still living in the enjoyment of good health, as are also the other members of his family, consisting of two brothers and two sisters. His own health has always been excellent and, with the exception of the usual diseases incident to childhood and a short attack of "chills and fever" in the fall of 1885, has never suffered from fever or, indeed, any serious or recurring illness of any kind. Never had milky or bloody urine. His appetite and digestion are good, but he complains of nervousness and disturbed sleep, the result, probably, of irregular hours consequent upon his occupation of night cabman. Habits are good; is not a drinker, although indulges in an occasional glass of beer. His residence is located in a malarious portion of the city. He has never been out of Mobile and its immediate vicinity. The water ordinarily consumed for drinking purposes by himself and family is supplied by the "City Water Works", but occasionally derived from a drovo-well, the former being pumped up from a clear flowing creek into an open reservoir from which distribution is then made. Does not remember to have drank cistern or tank water, or any standing uncovered water. Eight years ago his right testicle passed up into the inguinal canal,where it has since lodged, and which he attributes to horseback riding, although he has no recollection of any injury connected therewith. The left testicle began to enlarge three years ago, was without pain, and, indeed, the only discomfort experienced therefrom is the inconvenience resulting from its bulk.

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[1] MS. letter from Dr. Guitéras to the writer.

[2] Guitèras, in MS. letter to the writer.

Examination shows him to be fairly nourished and apparently in good general health. The right testicle is atrophic, insensitive, and occupying a fixed position about the center of the inguinal canal. The left testis has the dimensions of a medium sized pear, is pyriform in contour, fluctuating, semi-translucent (by transmitted light), and painless, in a word, presenting the characteristic features of an ordinary hydrocele. The glands in both inguinal spaces are moderately enlarged and in chains,—each gland being easily outlined and traced to its association with another. There are also a few enlarged glands in the right axilla and the right cervical region, but no other lymphatic involvement is discernible, and, in fact, there is no evidence of any other disease whatever. The left tunica vaginalis was now tapped and $4^1/_2$ ounces of milky fluid withdrawn. Testicle neither enlarged nor painful. This fluid was alkaline in reaction, albuminous, of a yellowish milky color, and, as shown microscopically, contained numerous fat granules, some leucocytes, casts, and epithelial scales, and *embryonal entozoa* in active motion. Since then the sac has slowly refilled, and has been retapped twice, namely, November 7, 1887, when about $^1/_2$ ounce was removed, and three slides examined with the result of finding 14 of the embryo-menatodes; and May 19, 1888, with the removal of 1 ounce of fluid and a "find" of 5 embryos in three slides. These were all active and vigorous, and remained alive until desiccation of the liquid medium. Repeated blood examinations[1] were made, but always with negative results, although great care was observed in conducting them, and with due regard for filarial migration and inversion of this periodicity.

The embryo-filariæ from this case are accurately delineated in the accompanying illustrations—taken from photo-micrographs prepared by Dr. W. M. Gray, of Washington.

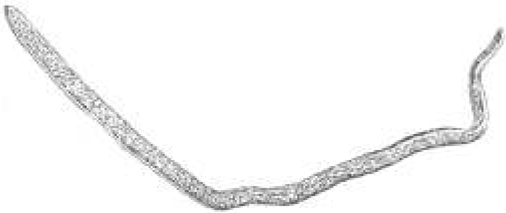

FIG. 1.—FRESH SPECIMEN OF EMBRYO-FILARIA SANGUINIS HOMINIS, FROM CHYLOCELE FLUID. × 300 DIAMETERS· (Photo-micrograph by Dr. W. M. Gray, Surgeon General's Office, Washington).

Figures 1 and 2 show the dead animal in the fresh chylocele fluid, and in which is seen the granular appearance or markings resulting from post mortem changes.

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[1] These examinations were made with a low power, at the following dates and hours:

Oct. 20,	1887,	7	P. M.	-	Blood from finger	tip ;	1	slide examined.
" 21,	"	9	"	-	"	"	1	"
" 22,	"	2.30	"	-	"	"	2	"
" 22,	"	11	"	-	"	"	2	"
Nov. 7,	"	12.30	"	-	"	"	1	"
" 23,	"	11	A. M.	-	"	"	1	"
" 23,	"	4	P. M.	-	"	"	1	"
" 23,	"	8	"	–	"	"	2	"
May 20,	1888,	9	"	-	"	"	3	"
" 25,	"	11	"	-	"	"	1	"

The specimens in Figure 3 were preserved in a $HgCl_2$ solution and then stained with eosin. These figures exhibit beautifully the characteristic sheath or chorional sac, from which the worm has retreated, giving it the appearance of being enclosed in a loose bag. This external envelope resisted the action of staining fluids.

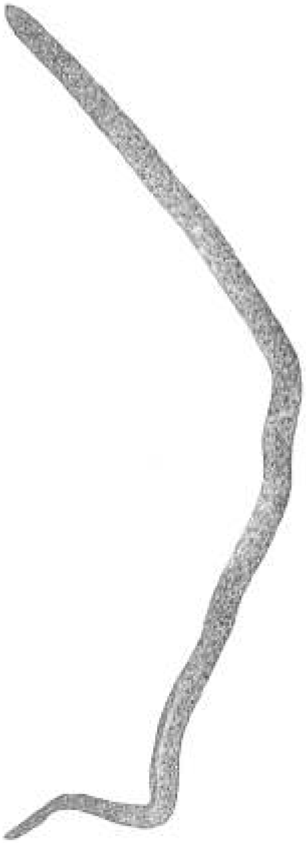

FIG. 2.—The same as Figure 1, × 650 diameters. (Photo-micrograph by Dr. W. M. Gray, Surgeon General's Office, Washington.)

What is the real etiological and clinical import of the presence of the mature[1] parasite, its ova and embryos in the blood-and lymph-systems? That it does possess a pathological significance of much importance and many phases must be conceded; and, notwithstanding the assertion, by several writers amply qualified to speak authoritatively on the subject, that the hæmatozoon does not always, or even generally, produce diseased conditions, and that guest and host may dwell together for years[1] in harmonious association, there are suffi-

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[1] It has been suggested with much reason that the mature worm may be as productive of diseased conditions as the embryonal forms.

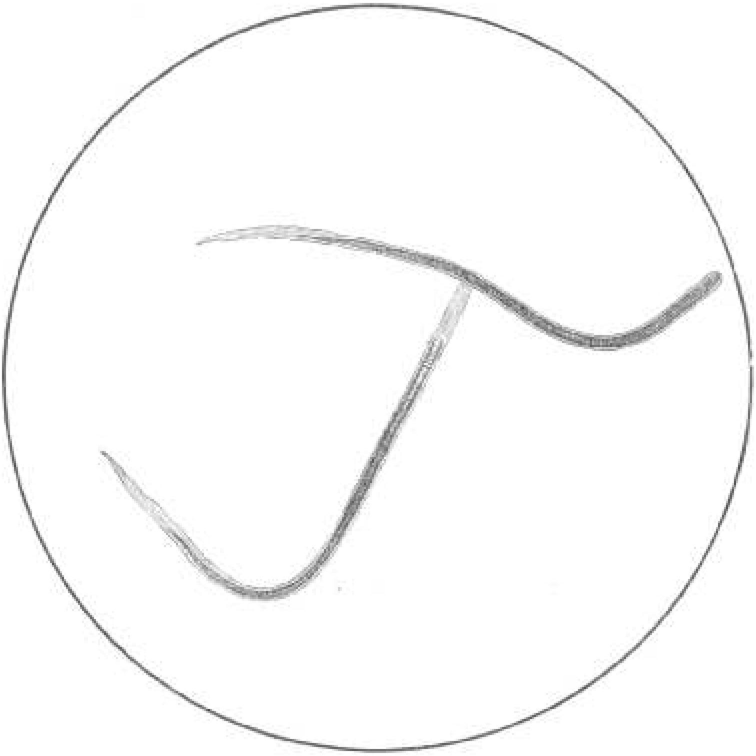

FIG. 3.—STAINED SPECIMENS OF EMBRYO-FILARIA SANGUINIS HOMINIS FROM CHYLOCELE FLUID × 300 DIAMTERS. (Photo-micrograph by Dr. W. M. Gray, Surgeon General's Office, Washington).

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[1] There are many examples attesting to the longevity of the animal. Dr. Lewis speaks of one patient in his practice in whom the filariæ were known to be present for two and a half years, and believes that they have no tendency to develop beyond a certain stage while in the circulation. (Eighth Ann. Rep. of the San. Comm.

TABLE OF FILARIA—CASES IN THE UNITED STATES.

No.	*Sex.*	*Age Color.*	*Occupation.*	*Date of Discovery*	*Pathological Condition Present.*	*Nativity.*	*Residence.*	*Fluid Containing Filaria.*	*Source of Potable Water.*	*Authority.*	*Remarks.*
1	F	M 40	Seamstress.	Feb. 13, 1886.	Chyluria.	Charleston, S C.	Charleston, S.C.	Blood.	Cistern water principally.	Jno. Guiteras in Med. News, April 10, 1886, also MS. letter to writer.	This case occurred in the practice of Dr. J. J. Edwards, who suspected filaria, and the presence of which was demonstrated microscopically by Drs. Jno. Guiteras and P. G. de Saussure.
2	M	N 20	Laborer.	March 6, 1885.	Chylocele, commencing elephantiasis scroti and mitral lesion.	Charleston, S.C.	Charleston, S.C.	Blood.	Cistern water principally.	Jno. Guiteras in Med. News, April 10, 1886, also MS. letter to writer.	This case also in practice of Dr. J. J. Edwards. microscopic examination by Drs. J. Guiteras and de Saussure, death from mitral lesion, no autopsy.
3	M	N 55	House Servant.	1886.	Chyluria.	Charleston, S.C.	Charleston, S.C.	Blood and urine.	Cistern water principally.	MS. letter from Dr. Jno. Guiteras.	Case in practice of Dr. de Saussure, who detected the filaria.
4	F	M 100	House Servant.	1886.	Superficial abscess, insanity.	San Domingo.	Charleston, S.C.	Blood.	Cistern water principally.	MS. letter from Dr. Jno. Guiteras.	Patient of Dr. de Saussure, sent to insane asylum, Columbia.
5	M	W 30	Constable.	1887.	Hemato-chyluria.	Charleston, S.C.	Charleston, S.C.	Blood.	Cistern water principally.	MS letter from Dr. Jno. Guiteras.	Patient in practice of Dr. de Saussure, lived in Nassau during late war.
6	M	N 65	Carpenter.	1887.	Chyluria-dysentery.	Charleston, S.C.	Charleston, S.C.	Blood.	Cistern water principally	MS. letter from Dr. Jno. Guiteras.	Patient of Dr. de Saussure, had frequent attacks of intestinal colic.

7	M	W 22	Cab-driver.	Sept. 27, 1887.	Chylocele.	Mobile, Ala.	Mobile, Ala.	Chylocele fluid.	Usually from city water works.		Patient of Dr. C. H. Mastin (senior), microscopic examination by Dr. Wm. M. Mastin.
8	F	N 32	Laundress.	1887.	Chyluria.	Charleston, S.C.	Charleston, S.C.	Blood.	Cistern water principally.	MS. letter from Dr. Jno. Guiteras.	Patient of Dr. de Saussure, the filariæ were found in the blood the night before labor, they were absent immediately after labor, but were present subsequently, not found in blood from the funis.
9	M	W 55	Nurse.	1887.	Lymph-scrotum, enlarged groin glands.	Ireland.	Charleston, S.C.	Blood.	Cistern water principally.	MS. letter from Dr. Jno. Guiteras.	Patient of Dr. de Saussure, microscopic examination by hospital physician, groin glands removed by Dr. Kinloch.
10	M	W 30	Lawyer.	1887.	Hemato-chyluria.	Charleston, S.C.	Charleston, S.C.	Blood and urine.	Cistern water principally.	MS. letter from Dr. Jno. Guiteras.	Patient of Dr. Kinloch, microscopic examination by Dr. G. M. Guiteras.
11	M	M 18	Sailor.	June 14, 1888.	Hemato-chyluria.	Charleston, S.C.	Charleston, S.C.	Blood.	Cistern water principally.	MS. letter from Dr. Jno. Guiteras.	Patient in Marine hospital, under charge of Dr. Jno. Guiteras.
12	M	W 45	Bookkeeper	June 1888.	Chyluria.	Charleston, S.C.	Charleston, S.C.	Blood.	Cistern water principally.	MS. letter from Dr. Jno. Guiteras.	Patient of Dr. J. L. Danson, Jr., this man often been on fruit vessels from Cuba, and may have taken water on board, has had chyluria since 1872.
13	M	N 58	House cleaner.	June 1888.	Chyluria.	Charleston, S.C.	Charleston, S.C.	Blood.	Cistern water principally.	MS. letter from Dr. Jno. Guiteras.	Patient of Dr. de Saussure, his wife probably also affected.

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cient grounds for assuming that a filaria-infested individual is rarely, if ever, in a state of absolutely perfect health.

The numerous observations upon and recorded instances of filarious diseases plainly show that the lymphatics are the principal, and, indeed, it might almost be said the sole seat of the parasitic attacks and manifestations. But whilst this is acknowledged, and, in addition, that lymphous discharges should be regarded as a symptom highly indicative of the existence of the parasite in the tissues, especially when occurring in tropical climates, yet more information is needed before it can be admitted with such positiveness, as declared by an intelligent and experienced observer, "that chylo-serous effusions may be considered as symptomatic of the parasitism." [2]

An idea of the number,[3] variety and character of the pathological changes referred to the presence of the worm can be readily obtained from a glance at the list contained in the following selected paragraphs. These quotations, as will be seen, are taken from authoritative sources, and comprise in the main those lesions the parasitic nature of which may be considered practically proven.

Dr. Bancroft, writing to Cobbold in 1877, remarks that he had on record,

"About twenty cases of this parasitic disease, and believes it will be the solution of chyluria, one form of hæmaturia, one form of spontaneous lymphatic abscess, a peculiar soft varix

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with the Govm't of India, 1871, Calcutta, 1872, Appendix E. p. 269). Dr. Hackley's case shows a duration of fully ten years (loc. cit); and Manson mentions a patient who had played the rôle of filarial host for 32 years (Filaria Sanguinis Hominis, etc., London, 1883). All of these cases, however, suffered from well-marked diseased conditions due to the presence of the parasite.

[2] T. R. Lewis. Quain's Dictionary Med. Art. Chyluria, p. 253.

[3] Dr. Manson (Filaria Sanguinis Hominis, 1883, p. 74) has collected statistics to show that on an average in Amoy (China) and the surrounding districts, about one in every eight persons bears the filaria sanguinis hominis; and that the embryo-nematodes will be found once in every thirteen individuals examined.

Dr. J. L. Patterson ("Veterinarian," June, 1879. Also: Cobbold, Parasites; etc., p. 201) and Dr. Hall (Cobbold. op. cit.) have ascertained that the proportion of the population of Bahia, Brazil, affected by the parasite is equivalent to eight and a half per cent.

of the groin, *a hydrocele containing chylous fluid*, together with some forms of varicocele and orchitis."[1]

He stated further that there were no cases of elephantine leg in the colony, or scrotal elephantiasis, or lymph-scrotum, but he believed the parasitic nature of these would be established.

A few years later Dr. Bancroft was able to extend this register of filarious diseases, and then wrote that the following conditions were probably associated with filaria:

"Chyluria, hæmaturia, anemia, tuberculosis, *hydrocele with milky fluid*, varicocele, elastic tumors in axilla and groin (helminthiasis elastica), lymph-vesicles bursting on scrotum and abdomen, skin diseases (craw-craw), acute orchitis, lymphangitis with fever, erysipelatous lymphangitis leading to hypertrophy of skin (elephantoid fever in short), elephantiasis of scrotum; and abscess of scrotum, of glands of neck (like struma), of the lymphatics of arm and thigh, intra-pelvic abscess, peculiar steatoma of face, venous varix, cerebral abscess and other lesions of the brain."[2]

Sir Joseph Fayrer says:

"It has been shown that disorders of the lymphatic system are most frequently associated with, if not caused by, the filaria; also nævoid and ordinary elephantiasis Arabum; perhaps also elephantiasis Græcorum,[3] chyluria, hæmaturia, *hydrocele*, and affections of the cord and testis, lymph varix and abscess, diarrhœa,[4] fever, cachexia, deterioration of general health, certain skin diseases (craw-craw), deafness, eye[5] diseases."[6]

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[1] Vide Cobbold, Parasites; etc,. p. 187.

[2] Vide Sir Josepn Fayrer, London Lancet, vol. 1, Feb. 15, 1879, p. 222.

[3] Dr. Manson believes that Elephantiasis Græcorum or leprosy is never produced by the parasite (The Filaria Sanguinis Hominis, etc., 1883, p. 3. Note).

[4] Dr. Guitéras (loc. cit. p. 402) was struck with the constancy of symptoms of intestinal dyspepsia accompanied by diarrhœa and often enteralgia, in the filariated cases which have come under his observation.

[5] Dr. Lewis found in a case of parasitic chyluria associated with granular lids and inflammation of the eyes, that a milky or chylous exudate flowed from the corners of the lids containing filariæ (Eighth Ann. Rept. San. Comm. with Govm't of India, 1871, Calcutta 1872. Appendix E. p. 247. Also: Fayrer, loc. cit. p. 188. Also: Cobbold, op. cit. p. 184).

[6] On the Relation of Filaria Sanguinis Hominis to the Endemic Diseases of India, London Lancet, vol. 1, Feb. 15, 1879, p. 221.

Dr. Prospero Sonsino gives a record of ten cases connected with filaria as follows:

"1st Case, had deafness and attacks of ephemeral fever, and Bilharzia disease; 2nd case, elephantiasis scrotalis and preputialis, abscess in thigh, diarrhœa and marasmus; 3rd case, lymphuria; 4th case, lymphuria and emaciation; 5th case, *lymphocele* (*milky hydrocele*); 6th case, *lymphocele* (*milky hydrocele*); 7th case, lymphuria with anemia and weakness; 8th case, lymphuria with anemia and weakness; 9th case, emaciation, chronic pneumonia, partial muscular disorders; 10th case, Bilharzia disease."[1]

And again, Dr. Manson asserts that "elephantiasis and allied diseases are much more frequently associated with the parasite than is any other morbid condition."[2]

The American cases comprised chyluria, hæmato-chyluria, *chylocele,* superficial abscesses, elephantiasis scroti, lymph-scrotum and groin glands, and with some of these was associated diarrhœa and dysentery.

The nature of the morbid processes just detailed not only bears out the assertion that the presence of filaria in the body is most commonly, and possibly always, evidenced through derangements of the lymph-system, but also it indicates that such manifestations are principally confined to the lymphatic divisions and radicles supplying the lower half of the body, and particularly those distributed to the pelvis and the urinary and genital organs. Hence, this nematoid hæmatozoon holds a place of no mean significance in the pathology of genito-urinary affections.

Manson's series of extensive examinations furnish additional exemplification of these facts, especially the latter, showing that elephantoid diseases, and, too, of the lower extremities, comprising elephantiasis of leg and of scrotum, lymph-scrotum, enlarged and varicose groin-glands[1], constituted 58 per cent[2] of the filarious cases.

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[1] Filaria Sanguinis Hominis, Lymphocele Lymphuria, and other Associated Morbid Disorders; with a Hint of Other Worm-Diseases in Egypt. Med. Times and Gaz. March 13, 1882, p. 294.

[2] The Filaria Sanguinis Hominis, etc, 1883, p. 80.

Chyluria, hæmato-chyluria, and hæmaturia together also give as large, and, in some countries[3] perhaps a larger proportion of cases. Dr. Lewis[4] considered all cases of chyluria occurring in India to be parasitic, since he found the embryos in nearly every instance, and, consequently, judged that the malady was local and intimately connected with a tropical climate. At the same time, he believed that obstructing causes other than that resulting from the helminth might produce the affection.[5]

In the opinion of Dr. Bancroft[6] chyluria probably always has a filarial origin in Australia, where, also, it is exceedingly frequent; and Dr. Manson[7] affirms that the majority of the cases met with in Amoy are filarious, and, furthermore, it is his experience that in five out of every six examples of the malady, where suitable and diligent search was made, the hæmatozoon has been discovered both in the blood and urine.

The observations of Dr. Guitéras lead him to the conclusion that chyluria is the most usual expression of the parasite in North America,[8] although he distinguishes two groups, the parasitic and the idiopathic, the latter largely predominating in frequency.

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[1] Manson is convinced that "varicose groin-glands, lymph scrotum, elephantiasis and chyluria are pathologically the same disease." (Cobbold, op. cit. p. 199.

[2] The Filaria Sanguinis Hominis, 1883, p. 80, table.

[3] Out of thirty cases of chyluria collected by Roberts (Urinary and Renal Diseases, London, 1876, art. Chyluria), twenty-four of the number were either born or had resided in the Mauritius, Isle of Bourbon, Brazil, West Indies or India; and it is declared upon excellent authority that in these and other tropical countries the affection prevails endemically. Here climate is a markedly predisposing cause, and that cause resides, undoubtedly, in the presence of the parasite.

[4] Vide Cobbold, Parasites, etc., p. 184.

[5] Dr. Prospero Sonsino (of Cairo) remarks that in one case of lymphuria (chyluria) he was unable to find the embryo-nematode in either the blood or urine. This, of course, has been noted in other similar instances.

[6] Vide Cobbold. Op. cit. p. 187.

[7] Filaria Sanguinis Hominis, etc., 1883, p. 90.

[8] Dr. Guitéras states (MS. letter to writer) he has learned that chyluria has been frequent for many years in Charleston.

Out of the thirteen United States cases, nine were affected with chyluria and hæmato-chyluria. All four of the Cuban cases mentioned by Guiteras had chyluria.[1]

Probably coming next in the order of occurrence is chylous dropsy of the testicular vaginal tunic, known as *chylocele* or *chylous-hydrocele.*[2] This effusion is usually composed of a pure chylous or a chylo-serous liquid, coagulable, and of a lacteous or opalescent color; but, not infrequently, it may be apparently only a clear serous-like fluid, identical with an ordinary simple hydrocele, without the appearance of chyle admixture, and yet possess chylous or lymphous properties, and be produced by and contain filariæ.

In a tabular statement of sixty-two examples of filarious disorders, Manson[3] records six instances of "hydrocele;" and, he asserts, also, that it is not an infrequent accompaniment of filaria disease, and, perhaps, the only symptom of it.[4]

By reference to the lists, already mentioned, of Bancroft, Fayrer, and Sonsino, it will be observed that to this form of dropsy or effusion, termed by them severally "lymphocele," "milky-hydrocele," or "hydrocele," is given prominent notice and position.

Again, among the thirteen filarious cases in the United States, two were of this affection, or, in other words, chylocele stood in the ratio to the total number of cases as two to thirteen. Hence, the proportional frequency of this form of filaria manifestation, together with the sufficiently common occurrence of hydrocele in all countries, especially in some warm climates,—it having been shown to be very frequent in the East Indies, and that in Brazil one man in every ten is affected with hydrocele (Hyrtl),—the conclusion is natural that the parasite occupies a positive causal relation to very many dropsical effusions associated with the testis and scrotum. This is still strengthened by the fact that, in five out of the eight recorded discoveries of the parent worm, the animal was found in the tissues of the cord, testis and scrotum. However, it is necessary to remark that in chylocele, as in chyluria, both a *parasitic* and *idiopathic* class or group, must be recognized, and the latter being possibly in excess over the former.

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[1] Vide Guitéras, loc. cit. Also table of U. S. cases in this article.

[2] This condition was termed galactocele, by Vidal (de Cassis); chylous-hydrocele, by Busey; chylocele, by C. H. Mastin (senior); lymphocele, by Manson and others; milky-hydrocele, lymphous-hydrocele, filarial hydrocele, etc.

[3] Op. cit. p. 77-79.

[4] Filaria Sanguinis Hominis, etc., 1883, p. 12, note.

In an essay on the subject of chylocele, published in 1883[1], I assumed that the cases therein collected were due to an obstructive gonorrhœal lymphangitis of one or more of the glands into which empty the vasa afferentia of the cord, resulting in stasis, varicose dilatations,[2] thinning, and final rupture with leakage of lymph.

In none of these collected examples was there a parasitic history, although two of them were exposed to such a predisposing influence in point of climatic surroundings. In one of the other two instances, which came under my personal observation, the filaria was not discernible in either the blood or the chylous fluid, although carefully searched for, and hence the theory of *inflammatory* lymphatic obstruction maintained for them represented, doubtless, their real morbid condition.

It is probable, then, that some obstruction of the lymphatic vessels of the cord is always essential to the causation of chylocele; and in filarial cases it is believed that the ova of the parasite in question furnish the impeding or embolic masses. The explanation of the method by which obturation is thus produced, may be regarded as identical with that considered by Manson to be the true pathology of elephantoid diseases.

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[1] Annals of Anatomy and Surgery, Brooklyn, May, 1883.

[2] Dr. C. H. Mastin (senior) was the first to demonstrate the existence of a lymphatic varix on the surface of the tunica vaginalis. In a case of chylocele, in April, 1875 (Amer. Med. Bi-Weekly, Louisville, Ky., vol. ii, no. 25, p. 617, June 19, 1875), he opened the sac by an incision of three inches, recognized a ruptured varix at the junction of the cord with the testis, and, after snipping it off, surrounded the base with a silk ligature. On the cut surface of the stump was seen the open orifices of several small vessels.

In a like case, in June, 1881 (Annals of Anat. and Surgery, May, 1883), I practiced the same procedure. The varix was similarly located, and when abscised showed the patulous mouth of a single vessel, from which exuded lymph. Both cases speedily recovered, and without reaccumulation.

In the life-history of the filaria it was shown that the fully formed or out-stretched embryos offered no impediment or retardation to the natural onward flow of the lymph, for, having a diameter[1] about that of the lymph cell, they penetrate without difficulty wherever these corpuscles passed; and, therefore, with them they freely traversed the minutest channels of the lymphatic glands and emerged into the blood. On the contrary, this is very different with the semi-spherical ovum, where the immaturely developed embryo is still coiled up in its enveloping sheath within the uterine tube of the parent, since in this ova-state its diameters[2] far exceed that of the fully formed embryo; and, consequently, when it is prematurely discharged into the lymphatic vessels it affords the required embolism, the current is interrupted or stopped, and lymph-stasis and regurgitation results. Thus, it is only needed for a prolific female, aborting or miscarrying from some, as yet inexplicable, cause, to expel her ova in numbers into the lymphatic circulation to produce plugging, more or less complete,[1] of the lymphatic glands receiving the lymph from a limited or extended area, according to the location of the worm.

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[1] Dr. Lewis states (Eighth Ann. Rep. San. Comm. with Govm't of India, 1871, Calcutta, 1872) that the average diameter of the embryo-filaria is "about that of a red corpuscle, and its average length about 46 times that of its greatest width; that is to say, its greatest transverse diameter is about $^1/_{3500}$ of an inch and its length $^1/_{75}$ of an inch;" but he has occasionally seen specimens not more than half this size.

Cobbold gives the measurement of the fully formed embryo as follows: Length, $^1/_{200}$ to $^1/_{125}$ of an inch; breadth, $^1/_{3000}$ to $^1/_{2250}$ of an inch (Parasites: etc., p. 181); and again (l. c. p. 189) says that the embryos sent by Bancroft measured $^1/_{125}$ x $^1/_{2500}$ of an inch.

Manson (China Imp. Customs Med. Rept. Half year ended March 31, 1882, 23rd issue) found the diameter of the out-stretched embryo to be only $^1/_{3000}$ of an inch, and again he says (Filaria Sanguinis Hominis, 1883, p. 7,) that the embryo measures $^1/_{90}$ inch in length by $^1/_{3500}$ inch in width.

[2] Dr. T. R. Lewis (Quain's Dic. Med. Art. Filaria Sanguinis Hominis, p. 513) says that the ova in which the embryos were not yet distinctly evident measured $^1/_{1304}$x$^1/_{2000}$ of an inch; and that the ova in which the embryos were visible were $^1/_{666}$ x $^1/_{790}$ of an inch in size.

Cobbold (Parasites: etc., p. 181) believes that the eggs average $^1/_{1000}$ x $^1/_{1650}$ of an inch from pole to pole. Manson's measurements (China Imp. Customs Med. Rep; Half year ended 31st March, 1882, 23rd issue) for the ovum are $^1/_{750}$ x $^1/_{500}$ of an inch.

Dr. Manson briefly states this theory of elephantoid diseases as follows: "1st, parent filaria in a distal lymphatic; 2nd, premature expulsion of ova; 3rd, embolism of lymphatic glands by ova; 4th, stasis of lymph; 5th, regurgitation of lymph and partial compensation by anastomoses; 6th, renewed or continued expulsim of ova; 7th, further embolism of gland."[2]

The most frequent location of the mature parasite in chylocele would seem to be in the lymphatics of the cord, since in two instances out of the eight recorded discoveries of the parent nematode, it was found free in the fluid of the sac, —in one of which four specimens were withdrawn with the effused lymph at a single tapping. Thus, evidently, in this affection the adult worm probably resides directly in the afferent lymphatics of the cord, or, if elsewhere situated, then these vessels share in the lymph stasis and regurgitation caused by gland obstruction at a more remote point above; and hence these lymphatics become dilated and expanded into varicosities that rupture and pour out filaria-bearing lymph into the vaginal tunic.

With this interpretation of the morbid processes existing in parasitic chylocele, the treatment becomes clear and positive.

A few cases are recorded of the treatment and cure of chylocele by iodine or other irritating injections, as usually employed in simple serous dropsy of the sac. But, while such a measure may prove effective in some instances, for very obvious reasons it cannot be relied upon, particularly in the parasitic variety, and should never be substituted for the certain and radical procedure of free incision into the tunica, and ligation of the ruptured and leaking varix. The efficiency of this method is demonstrated by its successful application in two cases, to which I have already alluded; and this, together with the constant existence of an oozing lymph-varix, and the probable presence of the mature filaria in the superficial tissues of the cord, or, perhaps, free in the fluid of the sac, furnish all the necessary argument in favor of its general adoption.

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[1] This obstruction may be so complete as to prevent the passage of a single embryo, thus explaining the absence of the filariæ in the blood when existing in numbers in the gland lymph and lymphous discharge.

[2] Additional Notes on Filaria Sanguinis Hominis, and Filaria Disease, China Imper. Customs Med. Rept. Half year ended 31st March, 1882, 23rd issue. p. 13.

In recapitulation it can be assumed, that the filaria sanguinis hominis represents the pathological quantity in many forms of lymphatic diseases, and mainly those implicating the genito-urinary apparatus; that the nematode not only occurs in, but is, undoubtedly, indigenous to some portions of the United States, especially the South Atlantic and Gulf Coasts; and that all methods adapted to the treatment of the parasite upon general grounds are confined to preventive or prophylactic measures, which, in the present state of our knowledge, refer exclusively to the potable water supply—and this being resolved into the single and simple procedure of the perfect filtration of all cistern or uncovered water, or any drinking water whatever, to which the access of filarious mosquitoes is possible.

Note. —For the benefit of those interested in the history of *filaria sanguinis hominis*, and the pathological conditions ascribed to the presence of this nematoid hæmatozoon, I append a rather voluminous bibliography of the subject. A large portion of the works therein referred to have been examined personally by me. In its preparation I must acknowledge especial aid from that grand compilation, the Index Catalogue of the Library of the Surgeon General's Office, U. S. Army, and the elaborate publications of T. Spencer Cobbold, of London.

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LIGATURE OF SUBCLAVIAN ARTERY FOR AXILLARY ANEURISM.

By G. A. WRIGHT. F.R.C.S.

OF MANCHESTER.

ASSISTANT SURGEON AT THE MANCHESTER ROYAL INFIRMARY, ETC.

ROBERT L., æt. 49 years, was admitted under my care into the Manchester Royal Infirmary on December 8, 1887.

History.—Twenty years ago he had syphilis with secondary symptoms. He had always worked as a joiner. His health appears to have been good until last June, when he noticed a "nagging" pain in the right axilla, at its lower part, after his day's work was over. The pain was intermittent and did not prevent his working. About a month later he noticed a swelling which slowly increased until three weeks ago; since that time its progress has been more rapid. There has never been any swelling of the arm. He ceased working eight weeks ago.

Condition on Admission.—The patient is a tall large-framed man, somewhat spare but not unhealthy looking. There is a large tumor to be seen and felt in front of the axilla on the right side; the swelling is about the size of a cocoanut, and reaches from the floor of the axilla to the clavicle, and can be also felt in the posterior triangle projecting upwards behind the clavicle; there is a space of a clear inch or more between the swelling and the posterior border of the sterno-mastoid. Pulsation is well marked and expansile; there is no distinct bruit. On light pressure over the third part of the subclavian